of the house air higher, as it always is in the kitchens where steam is continually being sent into the air, then a temperature of 65° would be very comfortable. Such moisture can be introduced into the house air by increasing the evaporating area of the water-pans in the hot-air furnace or by placing similar pans over the super-heated steam coils of the steam-heated house.

Observations somewhat similar to the above were also made by Dr. H. J. Barnes[3] in his own office in Boston, and also in other buildings in Boston. By means of an apparatus of his own devising Doctor Barnes was able to maintain a mean relative humidity of 53 per cent in his own office. This device placed over the delivering register of the hot-air furnace evaporated on the average four and one-half quarts of water daily, and the resulting increased relative humidity kept the office comfortable at a temperature of 65°, while under the usual drier conditions the room must have a temperature of 70° or 71°.

TABLE 3.—*Dr. H. J. Barnes' table of relative humidities in various Boston buildings.*

Place and time.	Heated by—	Mean relative humidity.	
		Indoors.	Outdoors.
		Per cent.	*Per cent.*
City Hospital, 7 days, December, 1878......	Indirect steam..	29	71
Office of Dr. Barnes, 7 days, January, 1896..	Hot-air furnace.	27	73
Office of Dr. Ayer, 10 days, February, 1896..	Indirect steam..	36	70
Women's Hospital, 8 days, February, 1896..	Indirect steam..	24	71
City Hospital, 12 days, February and March, 1896..............................	Indirect steam..	38	74
Means..............................	....	31	71

SCIENTIFIC BALLOONING AND WEATHER FORECASTS.[1]

By Dr. K. BAMLER, Essen. Translated by Prof. A. G. MCADIE.[2]

One of the chief problems of aerology is the improvement of the forecasts. Every prominent daily paper now publishes a weather bulletin based upon a synoptic weather map. In our country [Germany] the material for this map is collected by the German Hydrographic Office, or Seewarte, in Hamburg, and the forecasts are prepared by some proper central office. The data used by the Seewarte in preparing the weather map are from stations having nearly the same elevations. They give us a picture of the meteorological conditions at the time, as they existed at the bottom of the sea of air. Long experience enables us in many cases to determine what the ensuing weather conditions will be. But so long as we do not know the laws underlying the variations of the individual meteorological factors, so long will forecasting continue an uncertain science; and these laws can never be determined from observations made at the surface of the earth, be they ever so painstaking. We must make observations at greater elevations, but not on high mountains, for such are not wholly free from the influence of the ground. We must rise into the free air and observe there, and this is the province of aerology.

The scientific results of the instrumental observations made in the balloons sent up on the international dates of November, 1907, by the Lower Rhine Society for Aeronautics, show how valuable such ascensions are for forecasting. On November 6 the balloon "Bamler," with Ernst Schroeder of Essen as pilot and Engineer Mensing as observer, ascended from Mülheim and after four and one-half hours landed near Goor, in Holland. On the 7th of November the balloon "Elberfeld," with Professors Silomon and Laubert, ascended from Mülheim and after a trip of four hours landed in Wesel. Both ascensions aimed to reach the greatest possible height and make detailed temperature observations at all levels. Altho both pilots used up all of the 200 kilograms of ballast in their efforts to keep the balloons steadily ascending to a maximum altitude, yet an elevation of only 2,400 meters was attained. This apparently poor record is readily explained by the temperature distribution, as we shall see later.

On November 6, the temperature distribution was as follows: At the start, 10 a. m., a light fog prevailed near the ground and a temperature of 2° C. was recorded, and this gradually decreased up to a height of 600 meters. At this level the balloon was above the layer of haze and the temperature now rose steadily until a height of 1,500 meters was attained.

At the same time the difference between the readings of the dry and wet thermometers increased, indicating that the air became drier with increasing altitude. This is more apparent in the following table:

TABLE 1.—*Humidity observations in the "Bamler," November 6, 1907.*

Altitude of balloon.	t_d	t_w	t_d-t_w
Meters.	°C	°C	°C
Ground...........	2	1	1.0
640..............	4	1.2	2.8
940..............	5	2	3.0
1100..............	6.3	2.3	4.0
1300..............	8.0	3.	5.0
1450..............	8.4	1.1	7.3
1500..............	9.0	....	....
1900..............	9±	....	4.0
2150..............	6.8	....	....

At the 1,450 meter level was the driest air noted during the ascension, with a relative humidity of only 14 per cent. The highest temperature, 9° C., was reached at 1,500 meters, and this temperature continued practically up to 2,000 meters, but the relative humidity increased so that at 1,900 meters there was a depression of only 4° C. Above 2,000 meters the temperature fell slowly, and at 2,150 meters read 6.8° C. Values at greater elevations could not be taken, owing to difficulty in controlling the balloon. Practically similar temperatures were found during the descent, except that near the earth's surface, owing to sunshine, the temperature had risen to 5° C.

How, then, are we to explain this unusual distribution of temperature? Unusual because there should be a fall in temperature with elevation averaging 0.5° C. for each 100 meters. The decrease is easily understood, since the air is warmed chiefly by the heat radiated from the ground. On a normal day the lower air will be warmest, and with increasing elevation the temperature will continue to fall. But in this case the reverse condition existed. It happened that on the dates under discussion a wide-spread area of high pressure with weak gradients, prevailed. In such high-pressure areas the upper air sinks slowly, gradually coming under greater pressure and thus warming and drying as it descends. Under such conditions also we expect to find the highest temperature and lowest humidity close to the ground. But the active radiation fostered by these long, clear autumn nights directly opposes such a distribution of temperature, and the chilled lower air layers tend to form a more or less heavy blanket of fog near the ground. Such a temperature inversion as is shown in these observations, namely, 17° C. in 2,000 meters, is a frequent occurrence in the mountain regions during fall and winter. Indeed it is not unusual, in the upper Rhine section, to find a fog layer 200 to 300 meters in thickness and a temperature of 0° C., while from Sulzer Belchen, at an altitude of 1,400 meters, are reported temperatures of 8° C. to 10° C. and a fine, clear view of the distant Alps.

In what way, then, can we utilize these observations in forecasting the weather for the following day? The forecast issued by the Berlin Weather Bureau was: "Along the coast slowly rising temperature with cloudiness and some rain in

[3] See "The arid atmosphere of our houses in winter" in the Trans. Amer. Public Health Assoc., 1898.

[1] Translated from Illust. Aeron. Mitth. 12te Jahrgang, 1908, p. 29-33.

[2] The translator wishes to acknowledge the kind assistance of Mr. Louis Ludholtz and Dr. C. Abbe, jr., in preparing this translation.

the northeast; it will continue generally dry in the interior." Based upon our experiences, we would have said about as follows:

As a movement of the prevailing high pressure area is not expected, dry still weather, and during the mid-day hours free from cloudiness, will continue for several days. The temperatures will reach noticeably high values with very low humidities about mid-day. The proof of the correctness of these views can be seen from the weather conditions. If these continue, then the dynamic heating of the air must proceed from below, while during the night, on account of the rapid cooling of the earth's surface, the heat will indeed be dissipated, but during the afternoon hours a direct foehn-like heating will be shown.

The observations of November 7 give just such a chart as we would expect. At 11 a. m. there was a surface temperature of 11° C. and a wet-bulb difference of 3.5° C.; at 220 meters the temperature was 7° C., and at 480 meters it was 5.4° C. Above the fog layer, at 600 meters, the temperature was 9° C. with 6° C. difference. On the preceding day the temperature of 9° C. was first noted at a height of 1,500 meters; therefore the warm, dry air settled about 900 meters during the course of twenty-four hours. In consequence of this settling, the overlying layers were somewhat heated, so that the highest temperature, 11° C., was noted at a height of 740 meters, and the temperature continued at this figure up to 1,100 meters. Above this level, as during the preceding day at 900 meters, began the regular decrease in temperature and humidity, so that at 2,400 meters the temperature was only 1.0° C. with a wet-bulb difference of 5° C. The pressure distribution already described persisted until November 10, and each day during this period the mid-day temperatures exceeded 15° C.

It is also interesting to note the behavior of the balloon under these temperature conditions. Usually if a weight of ballast equal to 1 per cent of the total weight of a balloon be expended, the balloon will rise about 80 meters, provided no other factors are involved. The balloons "Bamler" and "Elberfeld" each weighed about 1,000 kilograms as the outthrow of ballast began. At the beginning 1 per cent of this weight would equal 10 kilograms; but during the course of the ascension, after say 50 kilograms of ballast had been used, 1 per cent of the remaining weight would equal only 9.5 kilograms, and after 100 kilograms had been used 1 per cent would equal only 9 kilograms. To make the balloon rise 200 kilograms of ballast had to be expended, and according to theory the balloon should have then ascended 1,800 meters. In both cases the expenditure of ballast began above the fog layer, i. e., at about 700 meters. Therefore the maximum height reached should have been $700^{m} + 1,800^{m} = 2,500$ meters. As a matter of fact the height reached was only 2,400 meters. In a normal distribution of temperature, i. e., with constantly decreasing temperature, and with favorable insolation, the balloon should have reached a much greater height, for the sun rapidly warms the envelop and its contained gas, owing to the clarity of the upper air. Temperature differences as great as 30° C. between the contained gas and the surrounding air have been observed. Every degree of such a temperature difference raises a balloon filled with illuminating gas about 30 meters. Assuming that our contained gas was 20° warmer than the surrounding air, the balloon should have ascended 600 meters in consequence, making the maximum height 3,100 meters—an elevation that is often reached during similar ascensions. In our case, however, the cold gas was always advancing into warmer air layers [because of the inverted temperature gradient] and it was necessary, therefore, to use more ballast in the ascension than usually would have been required. Hence the moderate heights reached.

THE KITE STATION ON LAKE CONSTANCE.

By Ernst Kleinschmidt, Ph. D., Director. Dated Friedrichshafen, September 23, 1908. Translated by C. F. Talman.

The kite station on Lake Constance has been in regular operation since April 1 of this year. Its task is to make daily observations, when practicable, of the atmospheric conditions over Lake Constance. The principal object is to measure the temperature, humidity, wind direction, and wind velocity at different altitudes in the air. For this purpose suitably constructed registering apparatus must be lifted by kites or captive balloons; free balloons would be too costly for daily use, and besides too much time would be required to make available the records obtained by them.

Special methods of investigation are required on account of the wind conditions that prevail in the interior of Europe. The wind is generally too weak for kites, but, on the other hand, it is often too strong for captive balloons, the latter being forced downward by strong winds. This difficulty can be overcome if the reel holding the steel wire used for the flights can be readily moved about, as, for example, when it is mounted aboard a swift boat having a sufficiently large body of water to maneuver upon. In flying kites, if the wind is too weak the vessel runs against the wind, thus strengthening its effect. In sounding with captive balloons the vessel moves in such a manner as to keep the balloon directly overhead. In the latter case we can deduce the direction and velocity of the wind at each altitude from the course and speed of the vessel. A boat offers the further advantage that when the wind is so strong as to threaten the destruction of the kites we can lessen its effect by running *with* it.

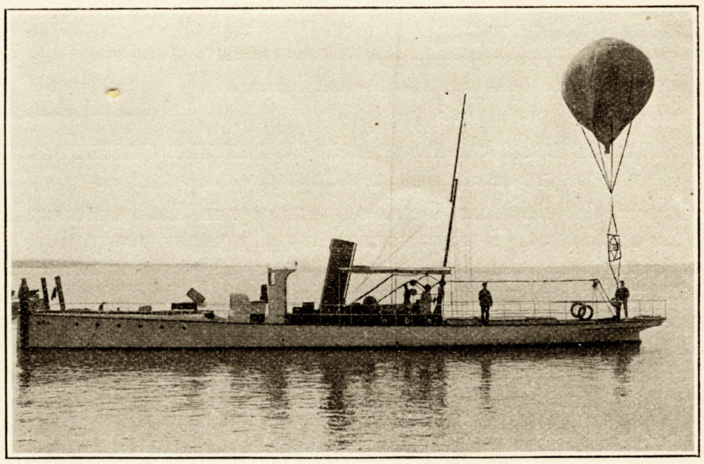

Fig. 1.—The German kite-boat *Gna*, Lake Constance.

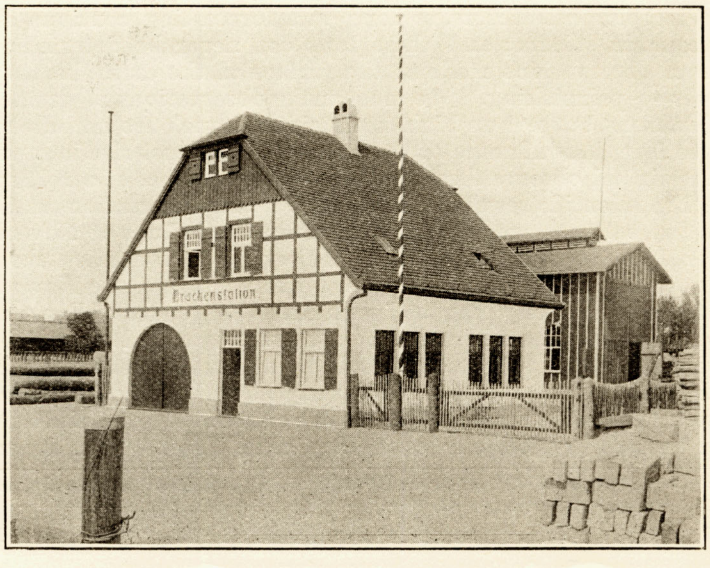

Fig. 2.—The German kite-boat station, Friederichshafen, Lake Constance.